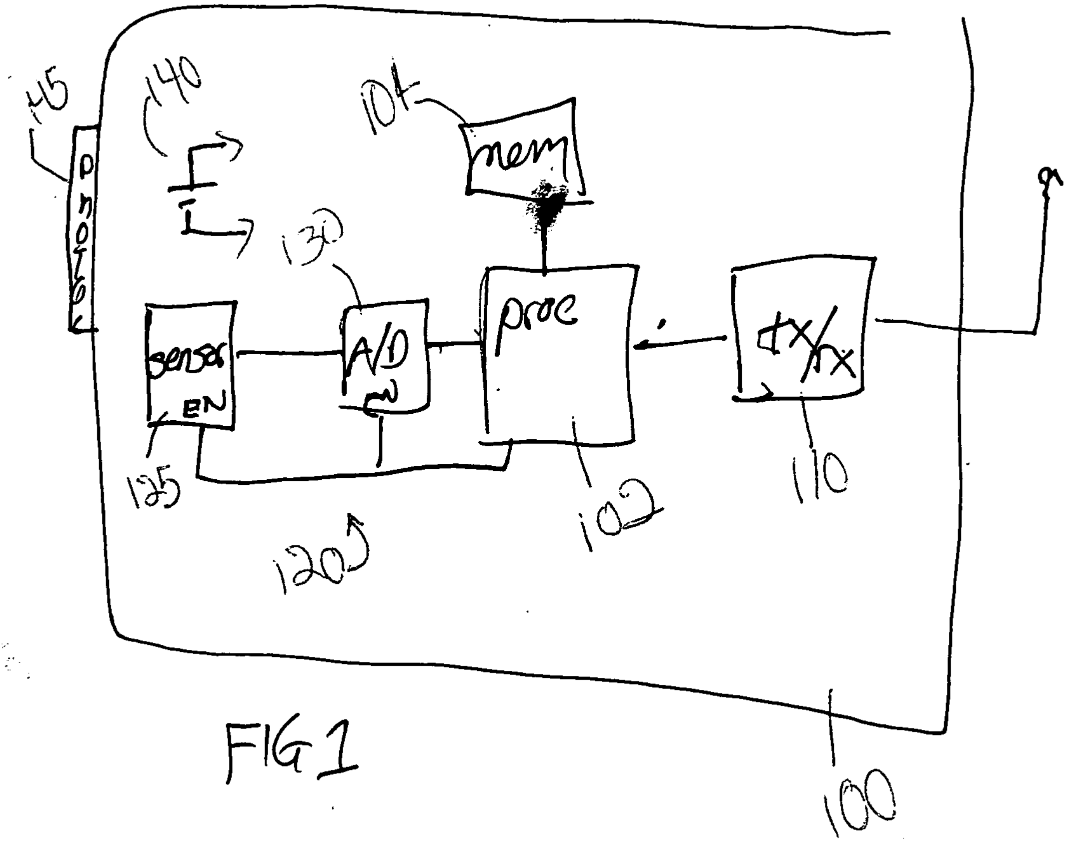

145
140
photo
104
mem
130
sensor
EN
A/D
proc
tx/rx
125
120
102
110
100

FIG 1

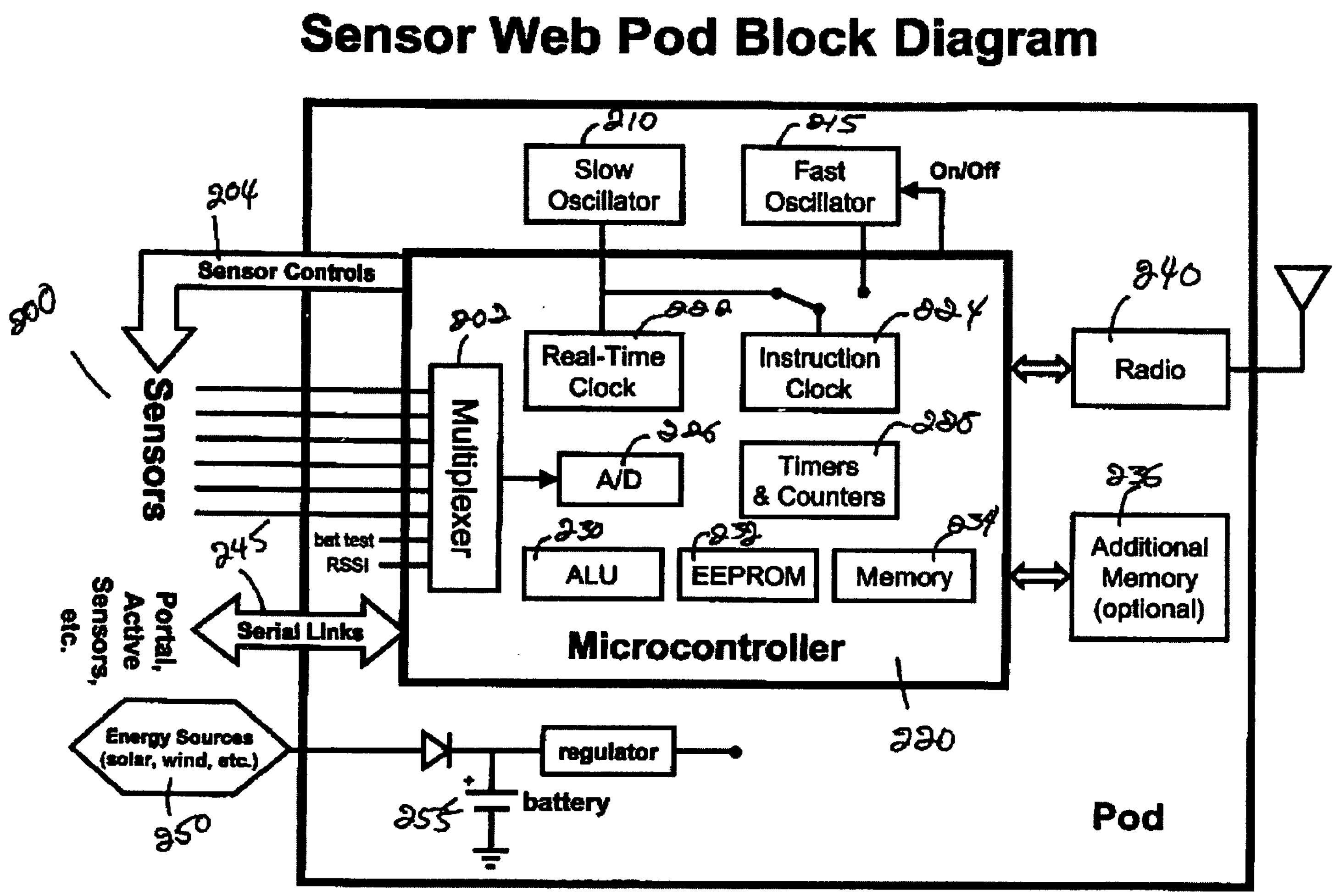
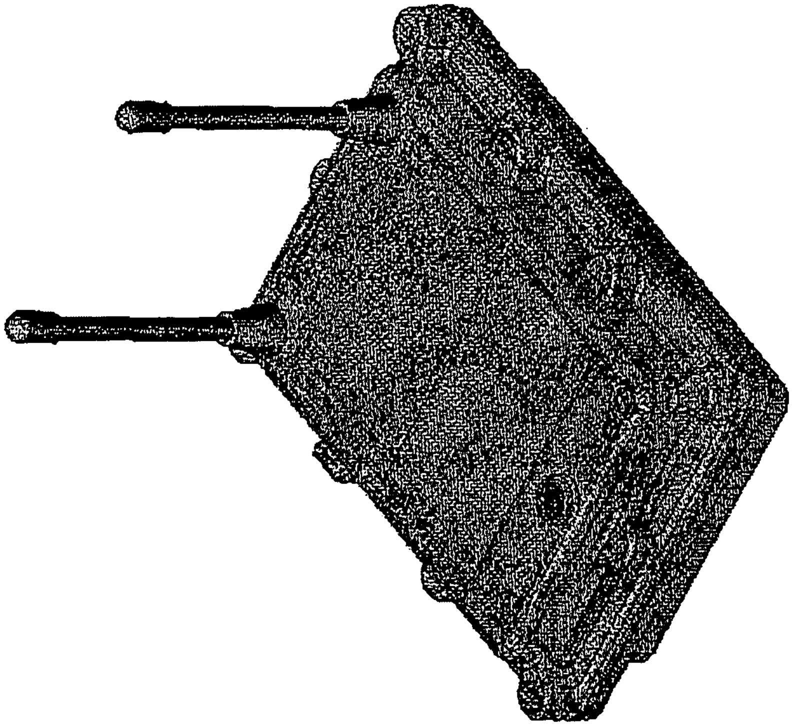

Sensor Web Pod Block Diagram
200
204
Sensor Controls
Sensors
210
Slow Oscillator
215
Fast Oscillator
On/Off
202
Multiplexer
222
Real-Time Clock
224
Instruction Clock
226
A/D
228
Timers & Counters
230
ALU
232
EEPROM
234
Memory
Microcontroller
220
240
Radio
236
Additional Memory (optional)
245
bat test
RSSI
Serial Links
Portal, Active Sensors, etc.
Energy Sources (solar, wind, etc.)
250
regulator
+
battery
255
Pod

FIG. 2



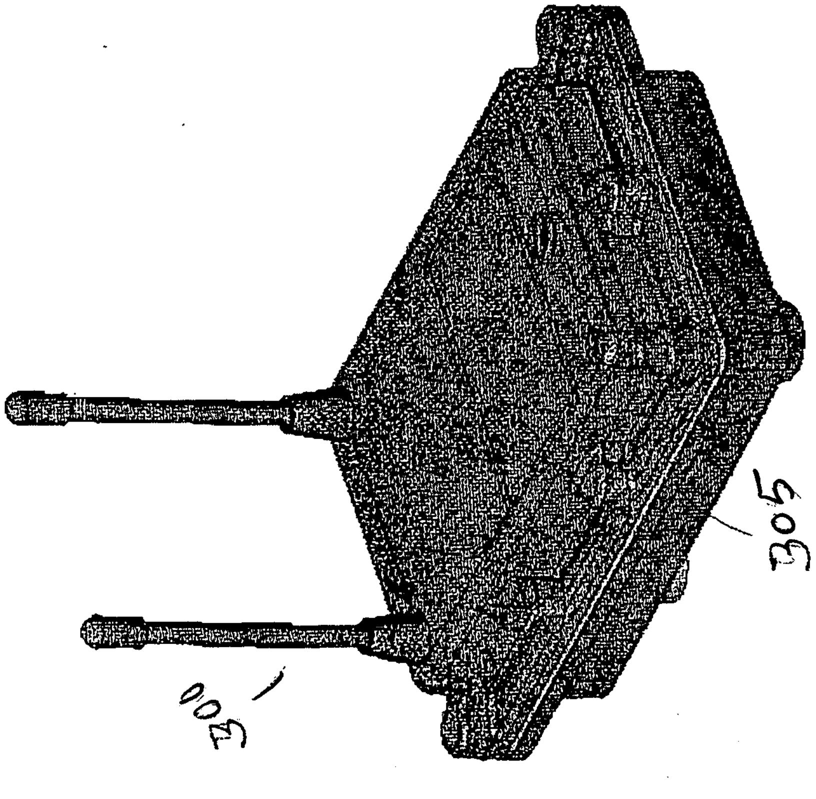
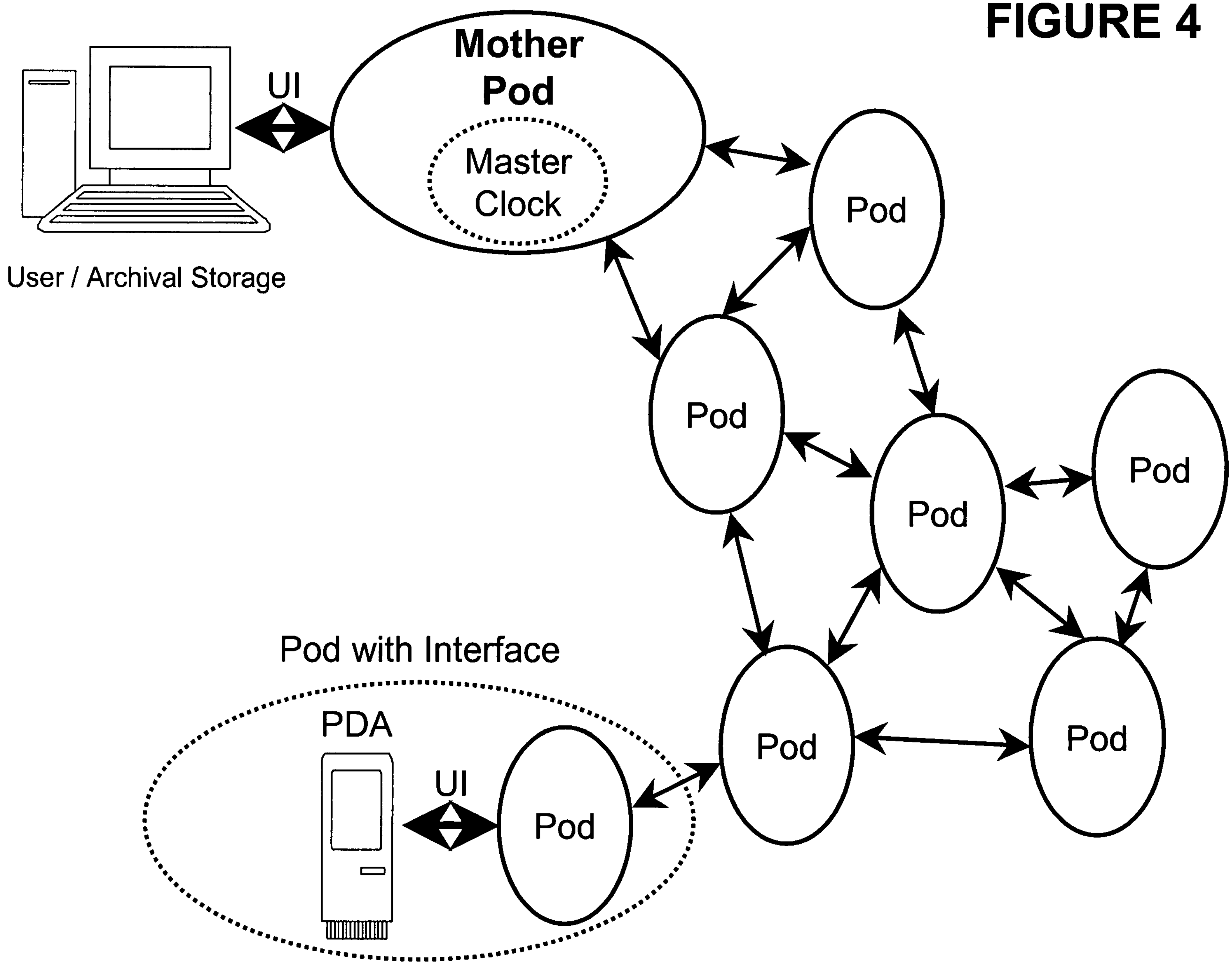


FIG 3

FIGURE 4


UI
Mother
Pod
Master
Clock
User / Archival Storage
Pod
Pod
Pod
Pod
Pod
Pod
Pod with Interface
PDA
UI
Pod

Sensor Web Protocols

Pod Power Up Sequence

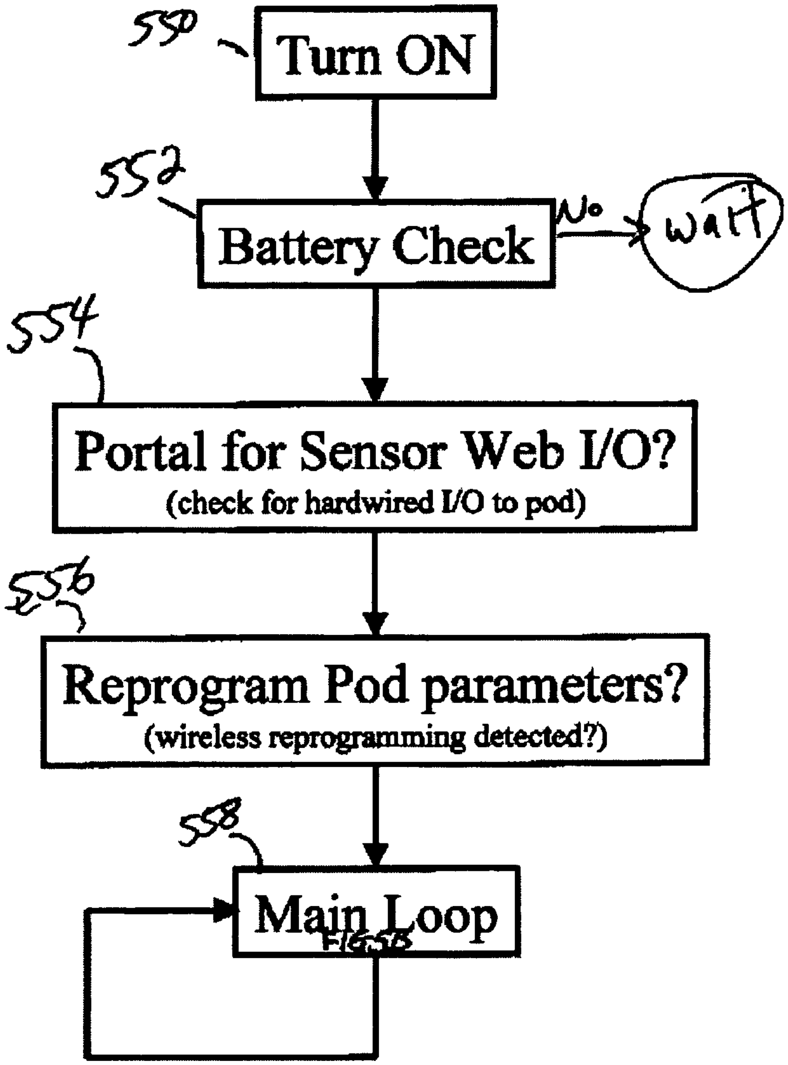

550
Turn ON
552
Battery Check
No
wait
554
Portal for Sensor Web I/O?
(check for hardwired I/O to pod)
556
Reprogram Pod parameters?
(wireless reprogramming detected?)
558
Main Loop
FIG 5B

FIG 5A

Sensor Web Protocols

Main Loop Sequence

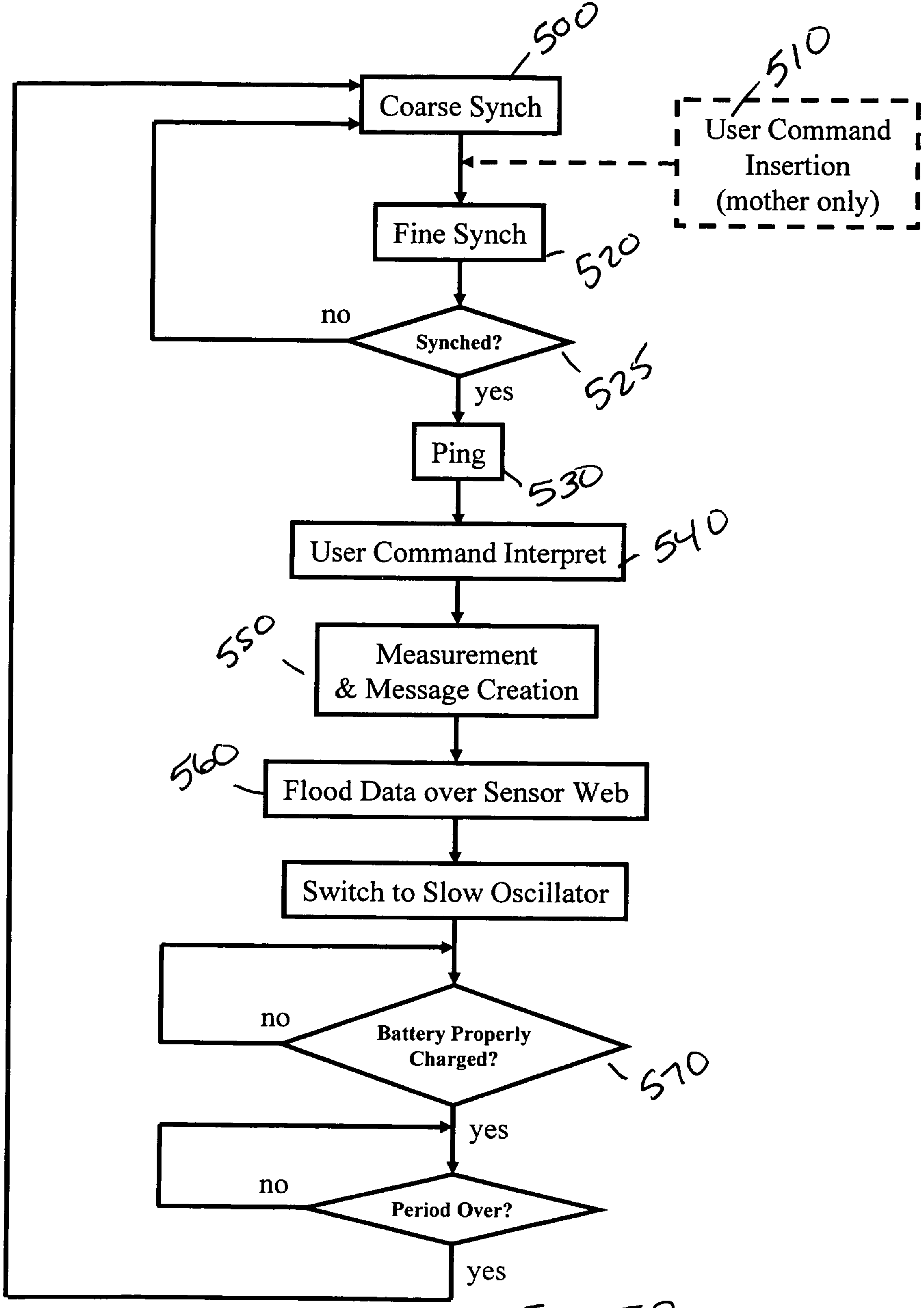

500
Coarse Synch
510
User Command Insertion (mother only)
Fine Synch
520
no
Synched?
525
yes
Ping
530
User Command Interpret
540
550
Measurement & Message Creation
560
Flood Data over Sensor Web
Switch to Slow Oscillator
no
Battery Properly Charged?
570
yes
no
Period Over?
yes

FIG. 5B

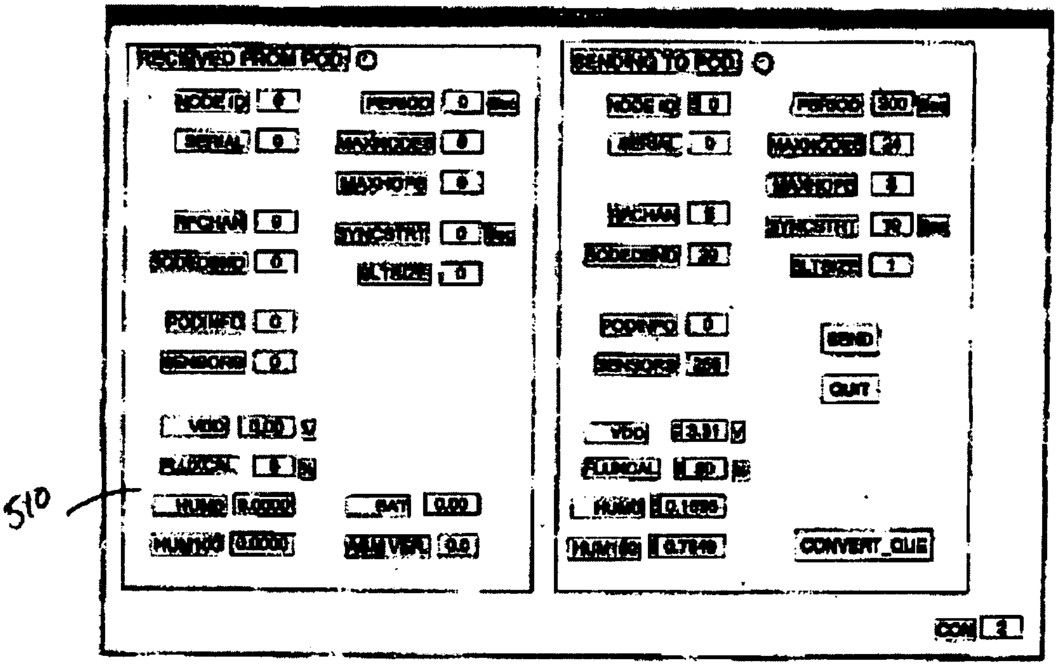
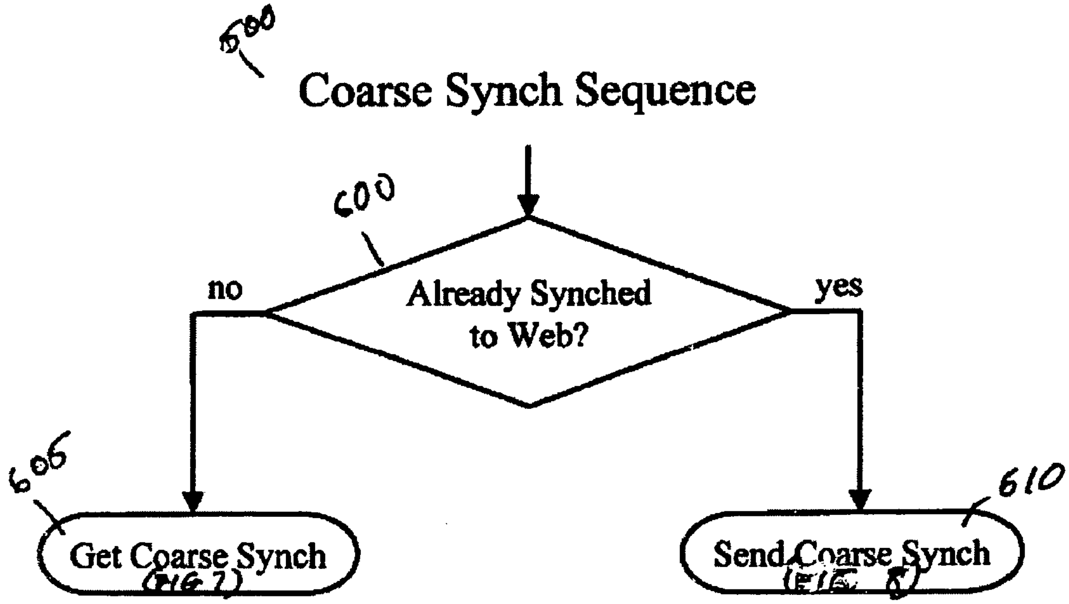

510
RECEIVED FROM POD
SENDING TO POD
NODE ID
SERIAL
PERIOD
MAXNODES
MAXHOPS
RFCHAN
SYNCSTRT
SLTSIZE
PODINFO
SENSORS
VDD
HUMID
BAT
SEND
QUIT
CONVERT_QUE
CON

FIG. 5C

Sensor Web Protocols

Coarse Synch Sequence



Note: Mother Pod is by definition always synched to the Sensor Web since it contains the Master Clock

FIG. 6

Sensor Web Protocols

Coarse Synch Sequence

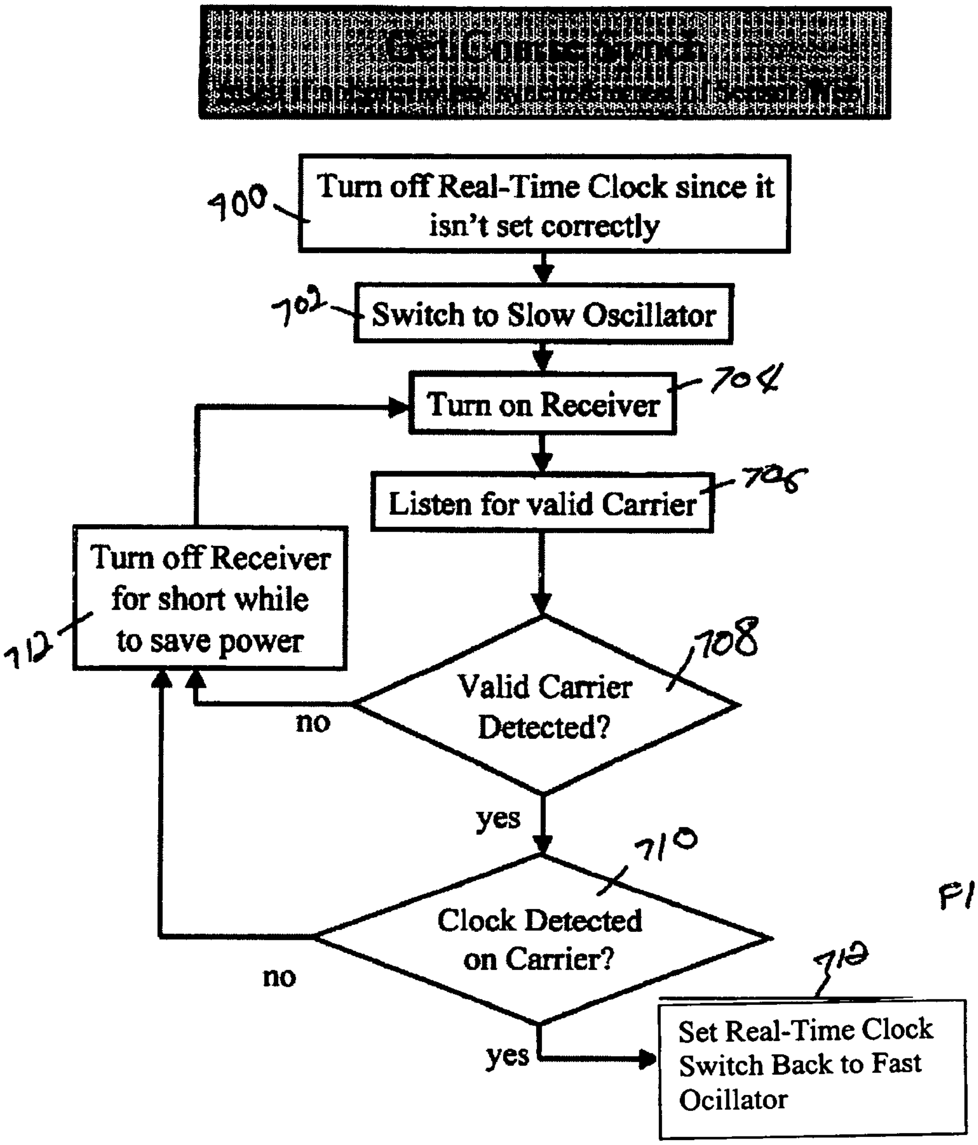
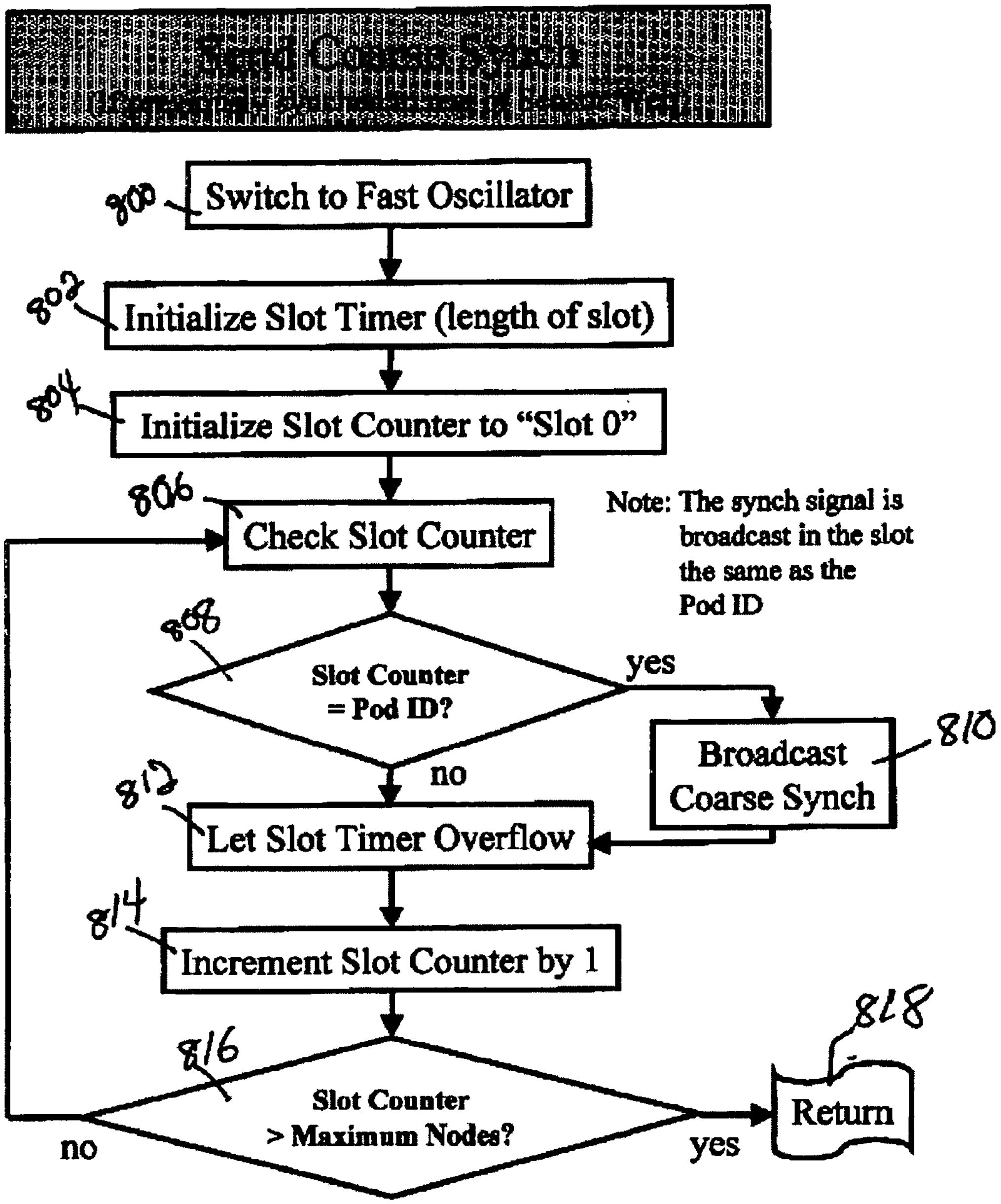


FIG 7

Sensor Web Protocols

Coarse Synch Sequence

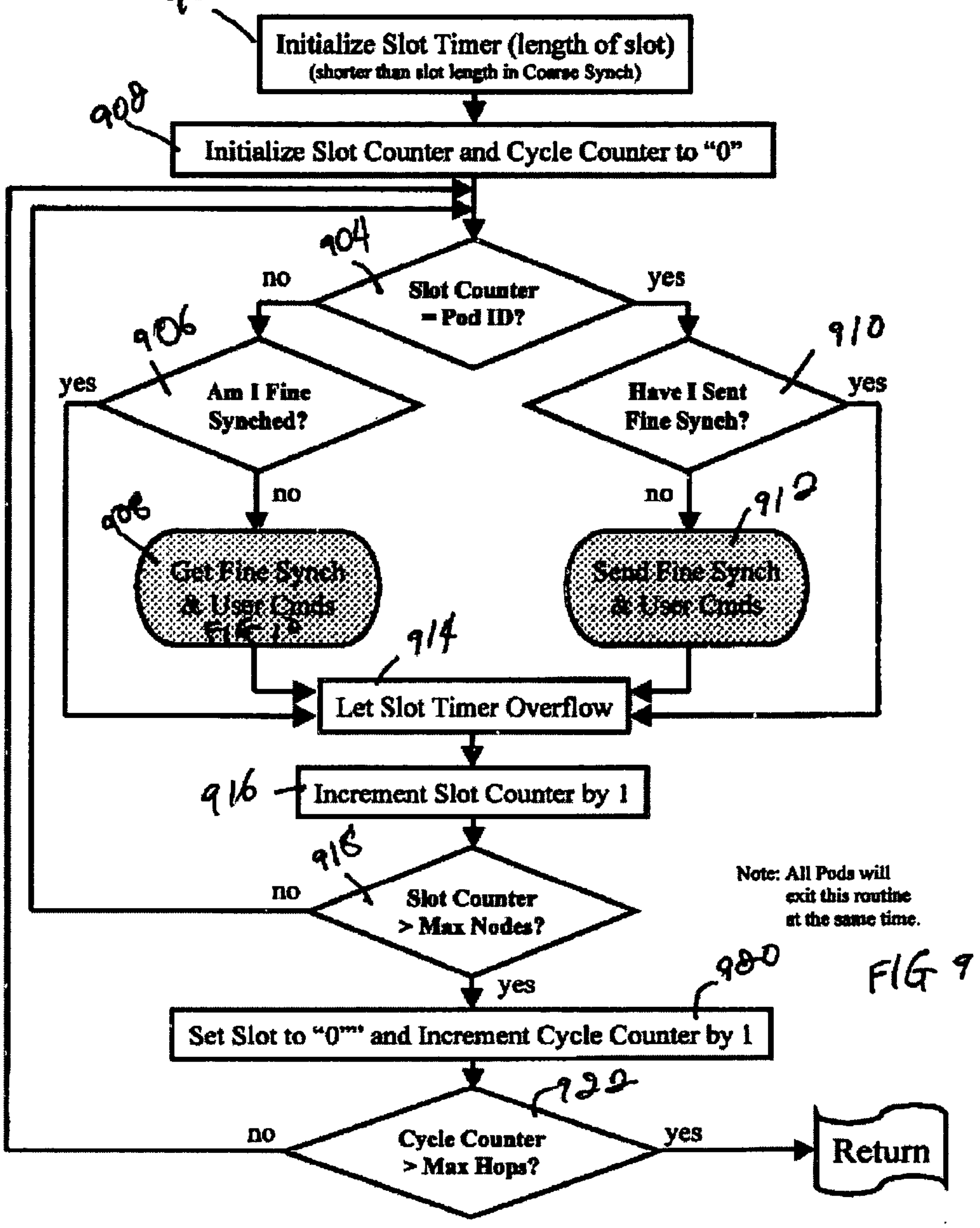


Note: The synch signal is broadcast in the slot the same as the Pod ID

FIG. 8

Sensor Web Protocols

Fine Synch Sequence


902
Initialize Slot Timer (length of slot)
(shorter than slot length in Coarse Synch)
908
Initialize Slot Counter and Cycle Counter to "0"
904
Slot Counter = Pod ID?
no
yes
906
Am I Fine Synched?
910
Have I Sent Fine Synch?
yes
no
no
yes
908
Get Fine Synch & User Cmds
FIG 12
912
Send Fine Synch & User Cmds
914
Let Slot Timer Overflow
916
Increment Slot Counter by 1
918
Slot Counter > Max Nodes?
no
yes
920
Set Slot to "0"" and Increment Cycle Counter by 1
922
Cycle Counter > Max Hops?
no
yes
Return

Note: All Pods will exit this routine at the same time.

FIG 9

Sensor Web Protocols

Fine Synch Sequence

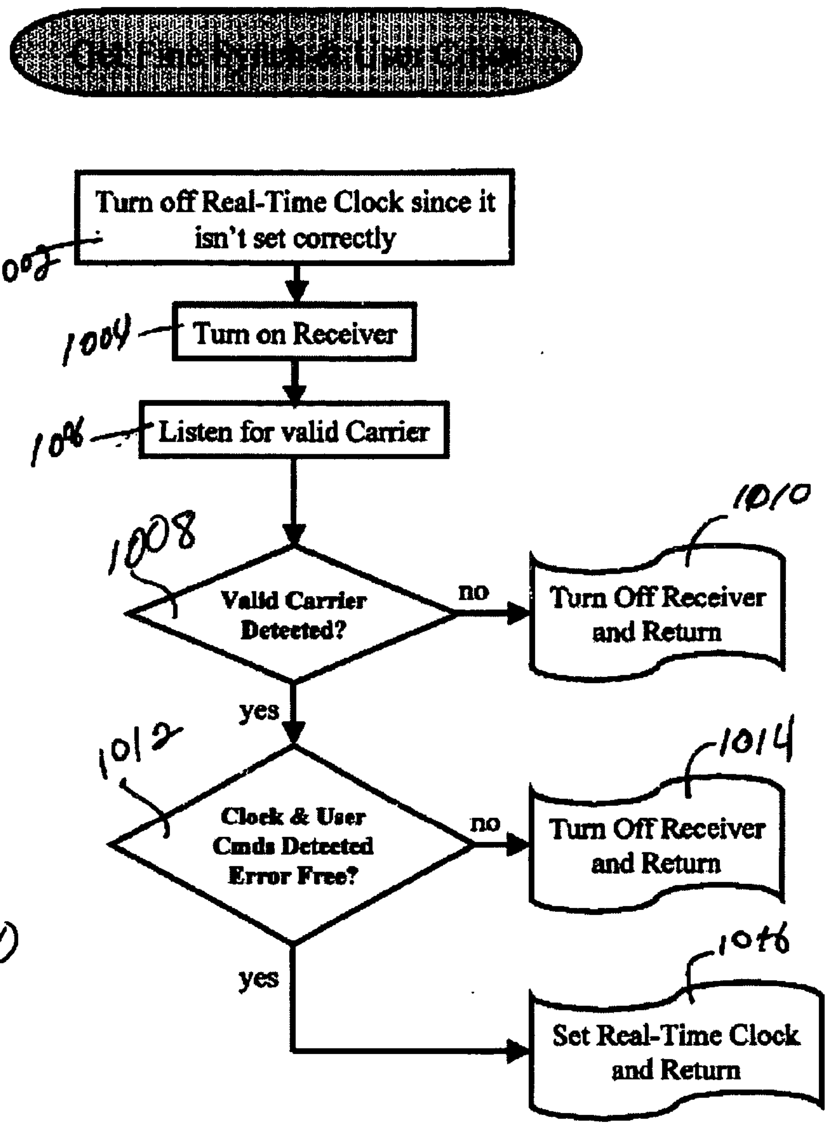

Get Fine Synch & User Cmds
Turn off Real-Time Clock since it isn't set correctly
1002
Turn on Receiver
1004
Listen for valid Carrier
1006
1008
Valid Carrier Detected?
no
Turn Off Receiver and Return
1010
yes
1012
Clock & User Cmds Detected Error Free?
no
Turn Off Receiver and Return
1014
yes
Set Real-Time Clock and Return
1016

FIG 10

Sensor Web Protocols

Fine Synch Sequence

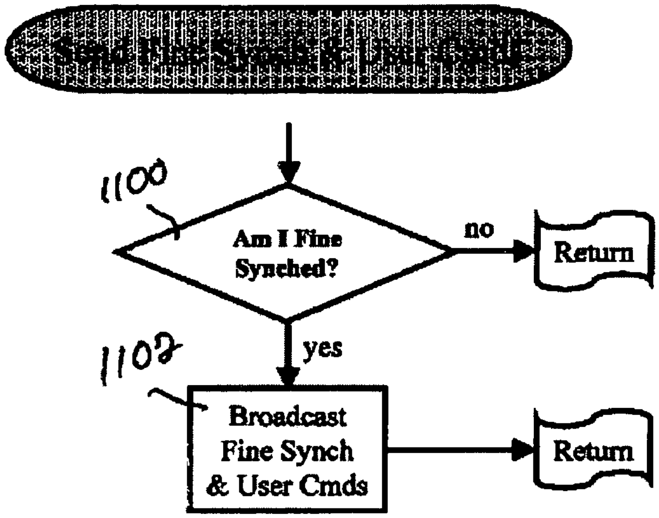


FIG 11

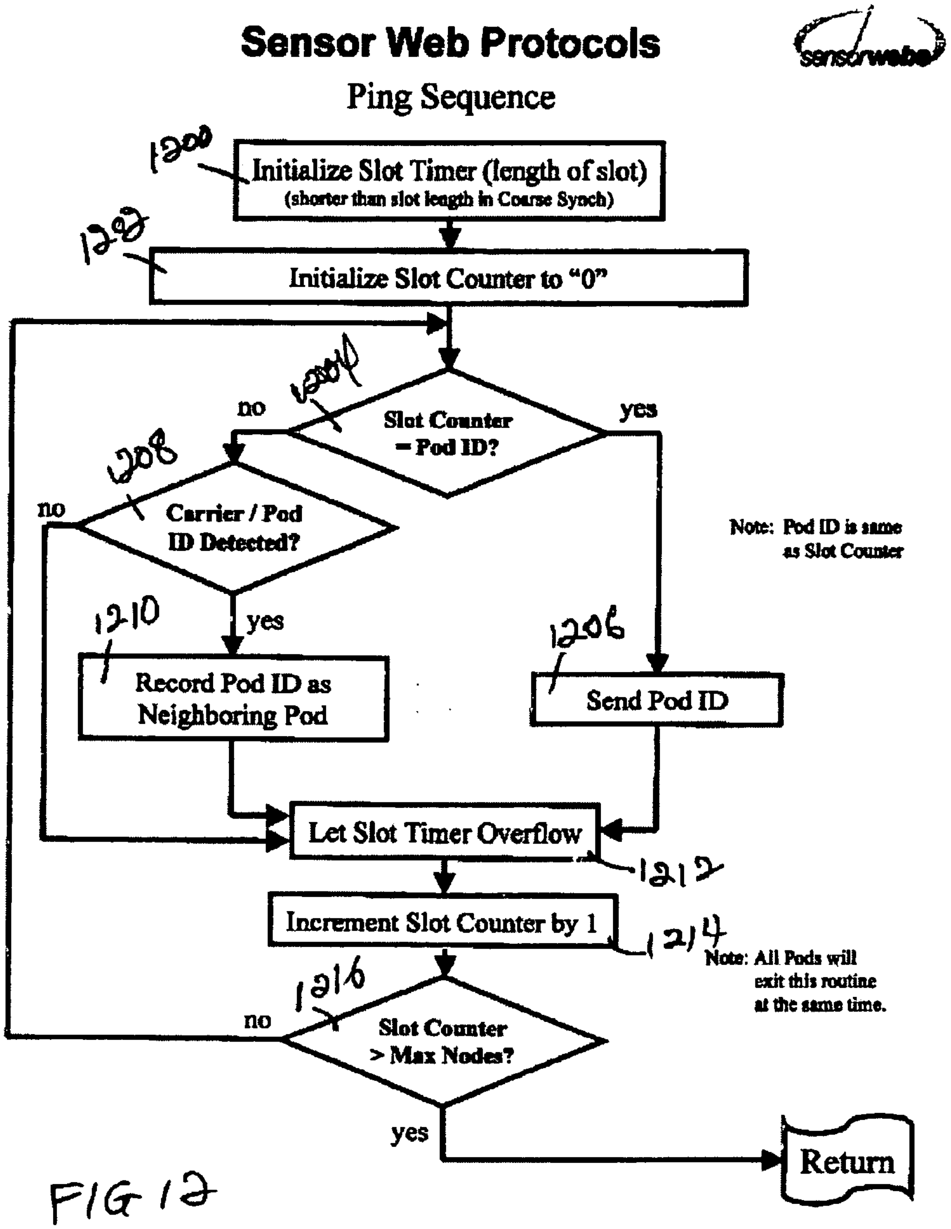
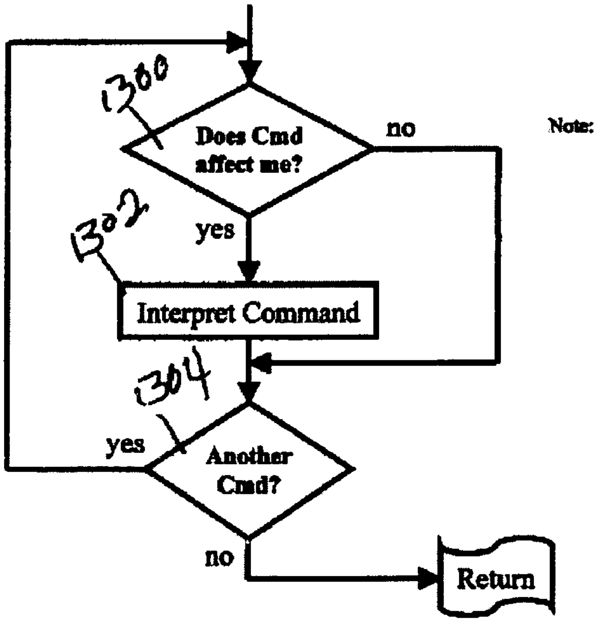

Sensor Web Protocols
sensorwebs
Ping Sequence
1200
Initialize Slot Timer (length of slot)
(shorter than slot length in Coarse Synch)
1202
Initialize Slot Counter to "0"
1204
Slot Counter = Pod ID?
no
yes
1208
Carrier / Pod ID Detected?
no
yes
1210
Record Pod ID as Neighboring Pod
1206
Send Pod ID
Note: Pod ID is same as Slot Counter
Let Slot Timer Overflow
1212
Increment Slot Counter by 1
1214
Note: All Pods will exit this routine at the same time.
1216
Slot Counter > Max Nodes?
no
yes
Return

FIG 12

Sensor Web Protocols

User Command Interpret Sequence



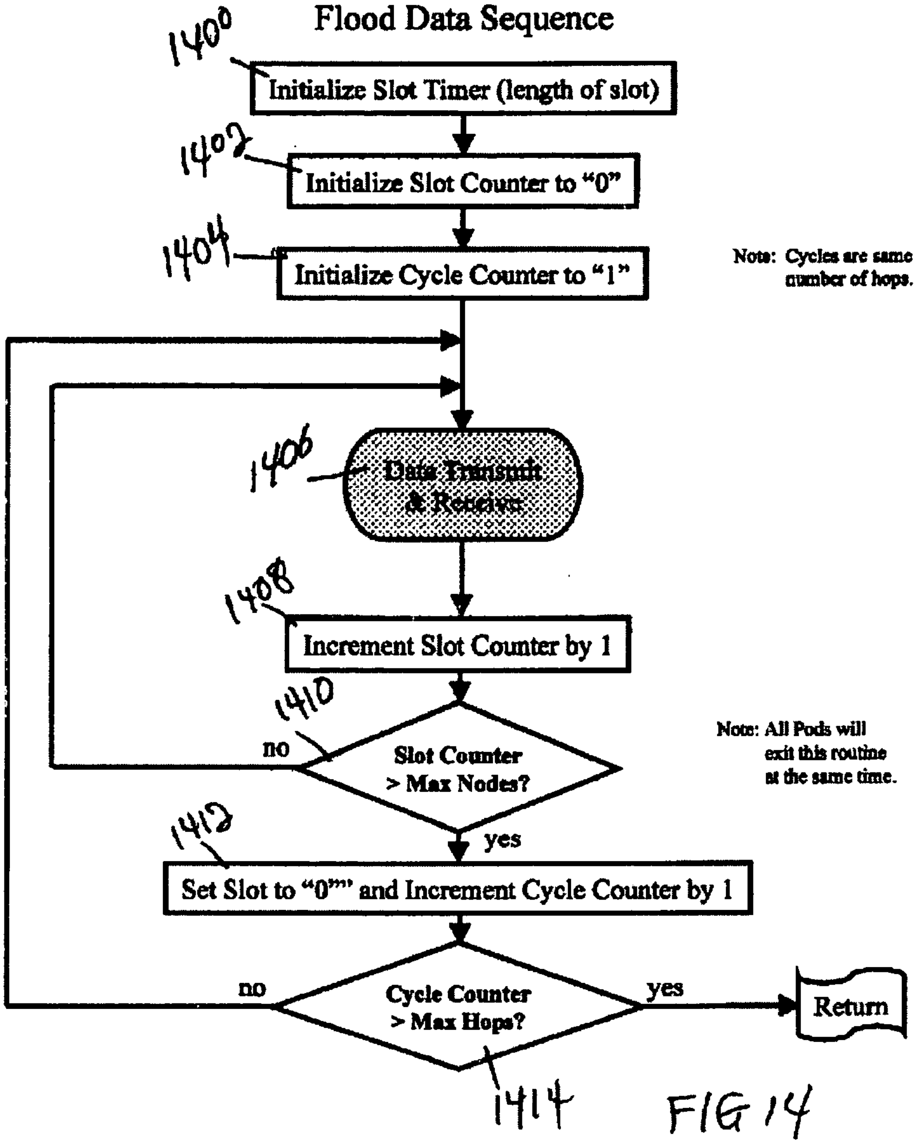
Note: Global Cmds affect every Pod

Fig 13

Note: The commands indicated here are the same ones that are passed during the fine synch sequence and are input into the system by the user. Commands have the form of (cmd, address, arg1, arg2, etc.) where the address can be a specific pod or all pods. Examples of these commands include having a pod activate an actuator, reset its ID, recalibrate a sensor setting, or change the period of measurement.

Sensor Web Protocols

Flood Data Sequence


1400
Initialize Slot Timer (length of slot)
1402
Initialize Slot Counter to "0"
1404
Initialize Cycle Counter to "1"
1406
Data Transmit & Receive
1408
Increment Slot Counter by 1
1410
no
Slot Counter > Max Nodes?
yes
1412
Set Slot to "0"" and Increment Cycle Counter by 1
no
Cycle Counter > Max Hops?
yes
Return
1414

Note: Cycles are same as number of hops.

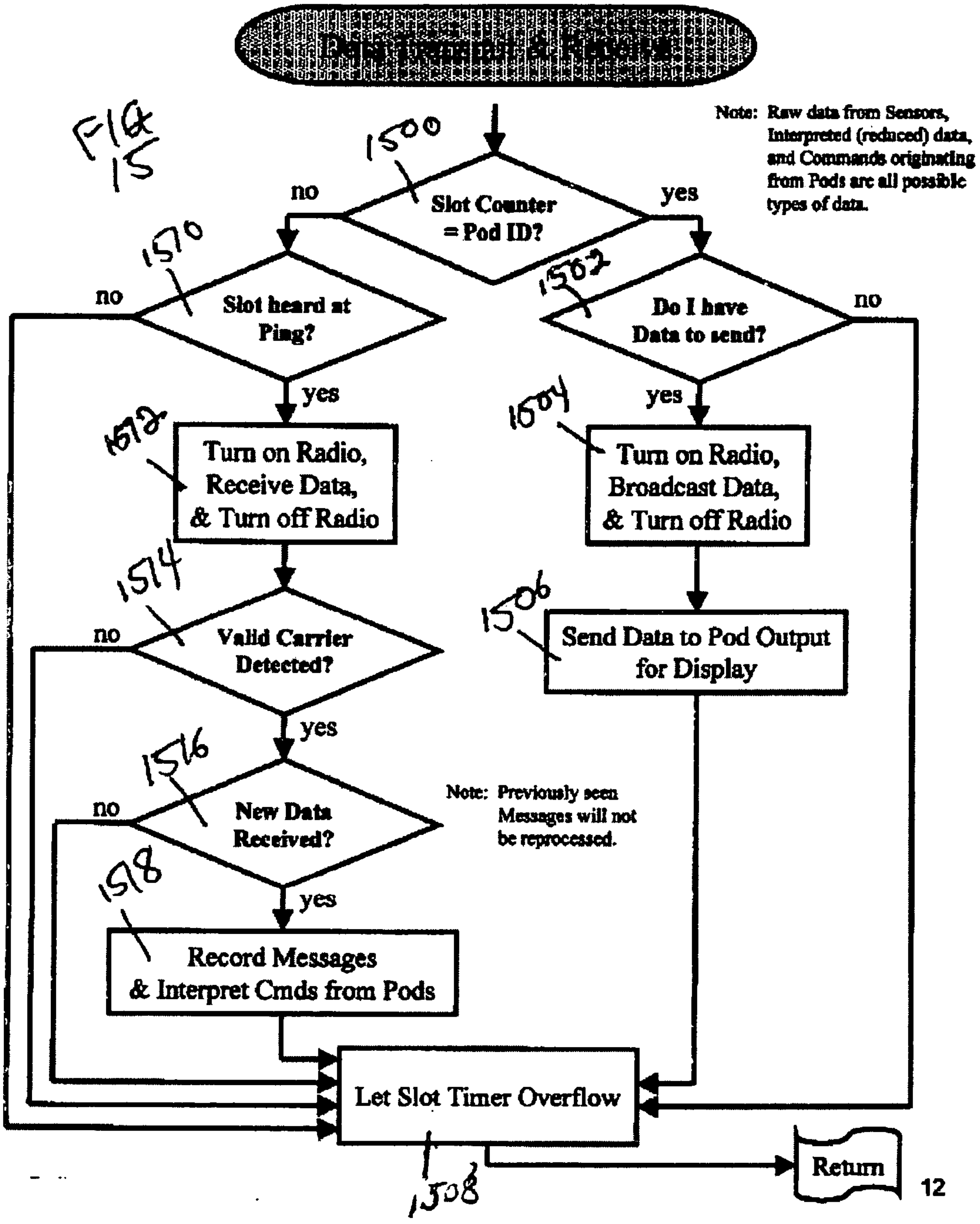
Note: All Pods will exit this routine at the same time.

FIG 14

Sensor Web Protocols

Flood Data Sequence

FIG 15



Note: Raw data from Sensors, Interpreted (reduced) data, and Commands originating from Pods are all possible types of data.

Note: Previously seen Messages will not be reprocessed.

Sensor Web Radio Packets

sensorwebs

Packet for Coarse Synch Phase

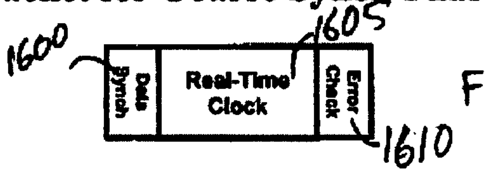


FIG16A

Note: Real-Time Clock is presently 3 bytes (but can be longer). Presently, 2 lower bytes is a 2 second counter with the upper byte the number of 2 second tics. Clock includes the offset required for receiving Pod to account for delays in transmission. Although only 5 bytes long, this packet takes a while to transmit/receive because it is done under the auspices of the slow oscillator.

Packet for Fine Synch Phase

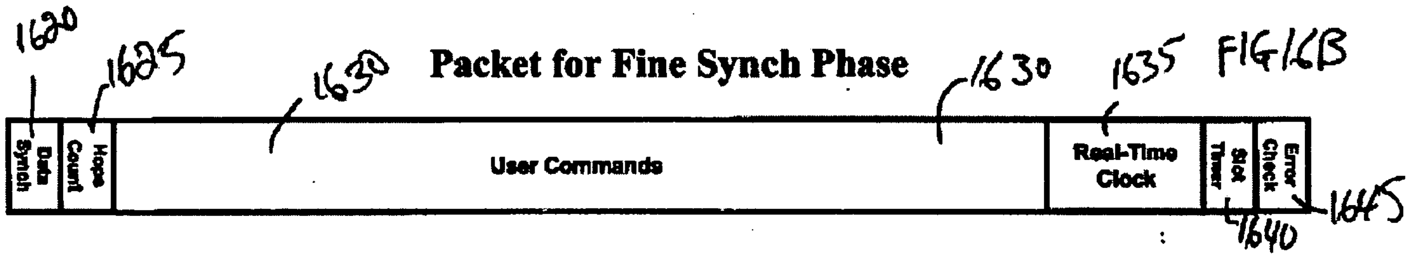


FIG16B

Note: Real-Time Clock is same as for Coarse Synch. Slot Timer is 1 byte and is used to time the transmit/receive slots (and includes offset to account for delays). Hops Count is a diagnostic that will be resent out during Flood Phase to determine a Pod's distance from Mother Pod (this counter is incremented every re-transmision during Fine Synch). User Command area is currently 18 bytes (but can be extended depending on slot size, burst baud rate, etc.). Present total packet length: 25 bytes.

General Note: The Real-Time Clock is used for Main Loop Sequence periodicity, timing of major phases, etc. The Slot Timer is of higher accuracy and used by the radio to ensure synchronicity during broadcast/reception within major phases.

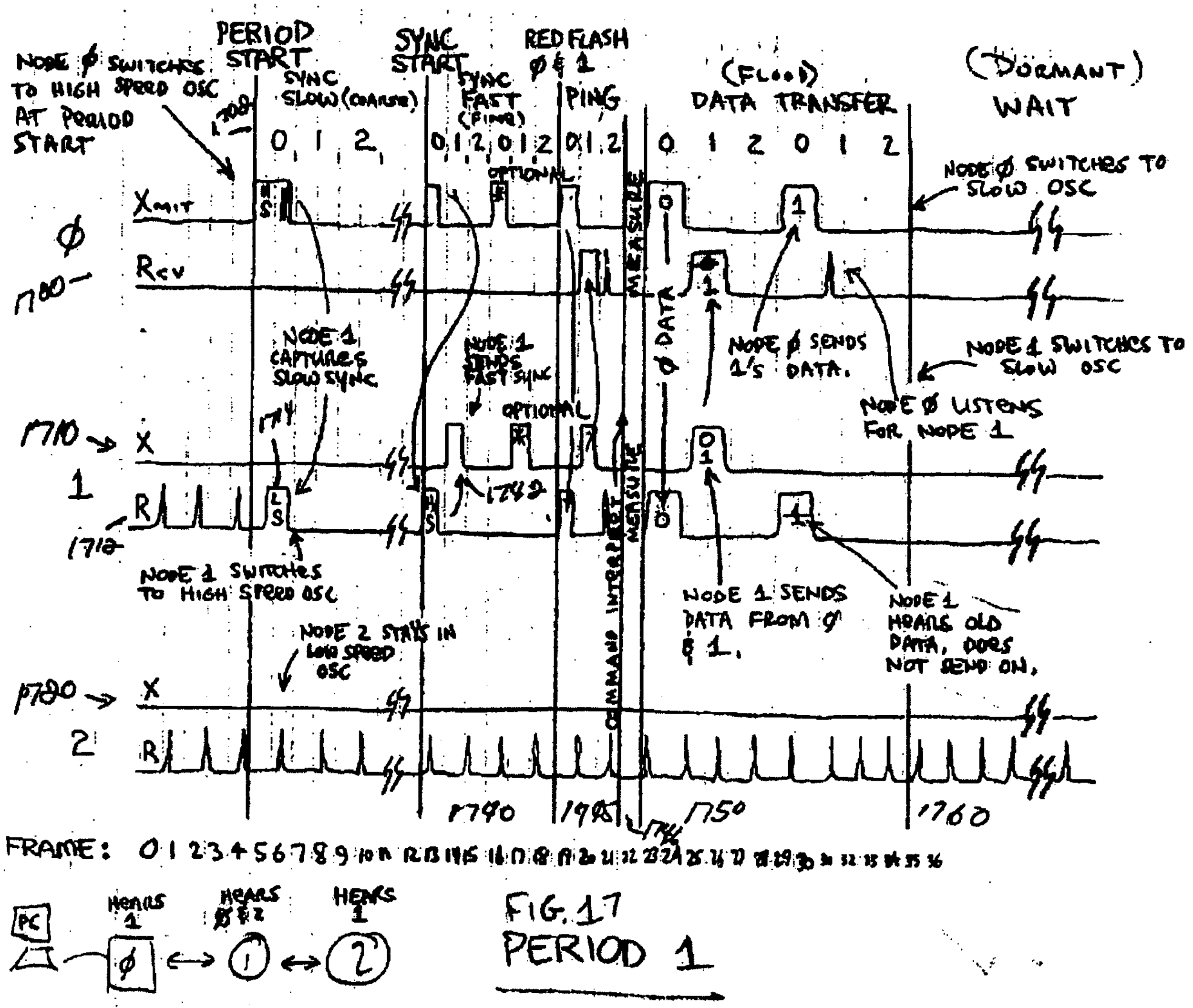
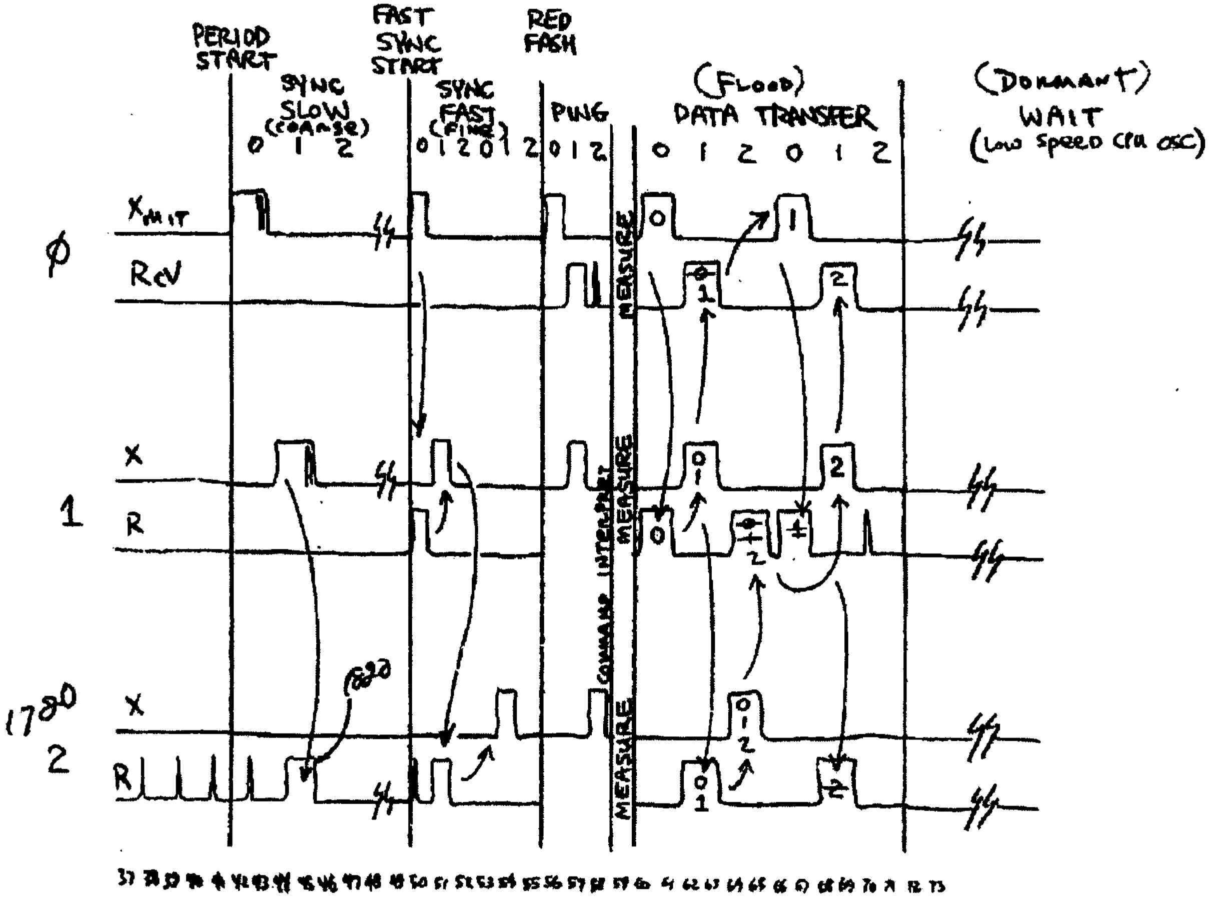

NODE ϕ SWITCHES TO HIGH SPEED OSC AT PERIOD START
PERIOD START
1700
SYNC SLOW (COARSE)
0 1 2
SYNC START
SYNC FAST (FINE)
0 1 2 0 1 2
OPTIONAL
RED FLASH ϕ & 1
PING
0 1 2
(FLOOD) DATA TRANSFER
0 1 2 0 1 2
(DORMANT) WAIT
Xmit
Rcv
ϕ
1700
H S
L S
MEASURE
ϕ DATA
0
1
NODE ϕ SWITCHES TO SLOW OSC
NODE 1 CAPTURES SLOW SYNC
NODE 1 SENDS FAST SYNC
OPTIONAL
NODE ϕ SENDS 1'S DATA.
NODE 1 SWITCHES TO SLOW OSC
NODE ϕ LISTENS FOR NODE 1
1710
X
1
R
1712
1714
1742
COMMAND INTERRUPT
MEASURE
NODE 1 SWITCHES TO HIGH SPEED OSC
NODE 1 SENDS DATA FROM ϕ & 1.
NODE 1 HEARS OLD DATA, DOES NOT SEND ON.
NODE 2 STAYS IN LOW SPEED OSC
1780
X
2
R
1740
1745
1744
1750
1760
FRAME: 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
PC
HEARS 1
HEARS ϕ & 2
HEARS 1
ϕ
1
2

FIG. 17

PERIOD 1



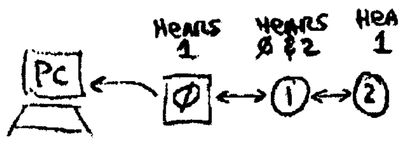


FIG. 18

PERIOD 2